Between 1:25 and 1:30 p. m. there were two flashes of lightning, only one of which was forked and was due west of the city at the horizon; there were also four dull but not distant claps of thunder.

Just at 1:30 by the clock on the Baltimore Sun Building, and after the lightning and thunder had ceased, came a terrific shower with drops [seeming] as large as half-dollar pieces and with hailstones ranging from the size of a pea to small a cherry. The hail fell continuously for 11 minutes, until 1:41 p. m., accompanied by huge raindrops which continued to fall for two minutes after the hail stopped, i. e., until 1:43 p. m. The hailstones had an average diameter of one-fourth to one-half inch and the larger sized stones did not appear until seven minutes after hail began to fall.

After 1:43 p. m. there was a fall of atomized spray for one minute and then the sun came forth to shine more clearly and brilliantly than it had done for a week or 10 days past. All the rest of May 1 the atmosphere was remarkably dry and clear; the wind was a variable northwesterly one of not more than 8 or 10 miles per hour.

551.515 (784)

PHOTOGRAPHS OF THE ANTLER, N. DAK., TORNADO OF AUGUST 20, 1911.

By Howard E. Simpson, Special Meteorological Observer.

[University, N. Dak., May 9, 1917.]

Tornadoes are very infrequent in North Dakota, but three having been reported to the Weather Bureau since the establishment of its service in this State in 1891. Finley, in his map of tornado frequency, places the State outside of the tornado area. The occurrence of these three and of the well-known Regina tornado far to the northwest in Canada, shows that recent and more complete data would greatly extend the area of known distribution in the Northwest. This does not mean that there is an actual enlargement of the area distribution of tornadoes, or that they are on the increase. It simply means that before the region was settled no tornadoes were reported.

One of the North Dakota tornadoes had the distinction of being international in its course and of having its characteristics recorded in a series of three photographs. The distance traveled by the storm between photographs was about 1½ miles; that by the photographer but a single village block.

The photographs are by Mr. W. H. Wegner, of Antler, N. Dak., to whom the Weather Bureau is indebted not only for the photographs, but for much of the information contained in this report.

The Antler tornado.

About 6:30 p. m Sunday evening, August 20, 1911, a tornado approached the village of Antler, Bottineau County, N. Dak. (lat. 48° 59′ N., long. 101° 16′ W.), from the west. At a point 1½ miles west of the village it turned slightly to the northeast and passed within a short distance of the city limits. It crossed Antler Creek 2 miles north of the village and followed the general course of the creek northeastward across the international boundary line into Canada.

Due north of Antler the storm struck Manning's Grove, on Antler Creek, where a large number of people were picnicking among the trees. In the total destruction of the pavilion, where many had sought refuge, and among the falling trees 22 were injured and 2 killed. Elsewhere two others were killed, and the property loss, chiefly in the form of farm buildings and grain in the field, probably exceeded $100,000.

Since the storm passed so close to town, a number of persons viewed it at close range, yet outside of the danger zone. The photograph shown in figure 1 was taken from the western edge of town, when the storm was 1½ miles to the west. Up to this point the storm was advancing almost due eastward upon the town, but here it veered off to the northeast, passing about 1 mile to the northwest of the photographer. Figure 2 shows the base of the funnel cloud at the point in its path nearest the village. Figure 3 shows the storm 2 miles distant and due north of the town. The photograph was taken just as it struck the grove on Antler Creek, where so many people were injured.

The first photograph of the tornado cloud is undoubtedly one of the best photographs of a tornado funnel ever published (Figs. 1, 4, and 5). The main overhanging storm cloud above a well-defined cloud level and the characteristic pendant funnel are well shown. The flying wisps beneath the cloud cover, the fuzzy margins of the funnel, and the low dust clouds trailing at its heel, all reveal the violent motion of the storm winds. The very local character of the destructive tornado winds is shown in the erect and motionless attitude of the young trees and bushes of the village, though a storm of the most violent type known to man is approaching at a distance of but 1½ miles.

The tornado at this point was not accompanied by the usual thunderstorm, and the clouds stand out distinctly against the light background of the evening sky. The photograph presents, therefore, with remarkable clearness the essential features of a tornado cloud not masked by the usual thunderstorm accompaniment.

The second photograph (fig. 2) was taken looking toward the west-northwest; the storm was nearer, less than a mile distant, and moving diagonally toward the right across the field of vision. A distinct tendency for the funnel to drag like the trail rope of a balloon is evident, and while the front edge is clearly defined the rear is ragged and partly obscured by dust and rain. The trees in the village are practically stationary in the region of calm without the tornado.

The exposure for the third photograph (fig. 3) was made looking due north, just at the moment when the storm was taking its largest toll of life and limb at Manning's Grove, on Antler Creek, 2 miles north of town. The storm is moving diagonally across the field of vision toward the right. On reaching the creek, a few moments before, it is reported to have turned gray in color. The funnel is here seen to be lagging at a still greater angle from the vertical; it has a well-marked heel as well as trailing cloud, and seems to be preceded by rain falling from the front of the upper cloud. It is less compact and shows signs of disintegration. The front of the storm has here reached the international boundary line. The storm path could be traced but a short distance in Canada, and the breaking up in this picture is believed to be the beginning of its dissipation.

Figure 5 is from a double print combining an enlargement of the first photograph (fig. 4) of the tornado cloud with a later photograph of the identical foreground under light conditions more favorable for the bringing out of detail. In this double print neither negative has been retouched. The double print was made to satisfy local and popular interest.

Other tornadoes on August 20, 1911.

The Antler storm was the most destructive of several tornadoes experienced in Bottineau County between 5:30 and 6:30 p. m. on the same day. At least 6 different funnel-shaped clouds formed within the single tornadic area as it passed over this county. Three were reported as being seen from Antler and 6 funnel clouds are reported as having been plainly visible from Souris, 27 miles east and 5 miles south of Antler. Serious damage was reported from but one of these funnels, viz, one which appeared 4 miles southwest of Souris, where it destroyed one farmstead, killing one man and injuring several others. After moving along the ground for but a short distance the funnel rose into the overhanging cloud and disappeared, but reappeared again for a short time as it approached the slope of the Turtle "Mountains" 6 miles to the east.

551.524 (794) (520)

SOME RESEARCHES IN THE FAR EASTERN SEASONAL CORRELATIONS.[1]

(SECOND NOTE.)

By T. OKADA.

[Reprinted from Journal of the Royal Meteorological Society of Japan, May, 1917, 36:41-49.]

1. *Correlation between the July temperatures at San Francisco, Cal., and Erimo in northern Japan.*—It is a well-known fact that in the summer season the North Pacific HIGH area is a controlling agent of the air temperature on both sides of the North Pacific. A slight shifting to the westward of this action-center gives temperatures below the normal on the western coast of the United States, and the eastward shifting of the HIGH area gives abnormally low temperatures on the eastern coast of northern Japan.

An opposition is traced between the July temperatures (x, y) at San Francisco in California and Erimo in Hokaido. We give below the July temperatures and departures (Δx, Δy), etc., at both stations.

TABLE 1.—*July temperatures at San Francisco and Erimo.*

[x in the second column means the air temperature at San Francisco, and y in the third column that at Erimo.]

Year.	x	y	Δx	Δy	$\Delta x . \Delta y$	$(\Delta x)^2$	$(\Delta y)^2$
	°C.	°C.					
1890	15.4	15.9	+1.1	+0.9	+0.99	1.21	0.81
1891	15.2	15.8	+0.9	+0.8	+0.72	0.81	0.64
1892	14.5	17.8	+0.2	+2.8	+0.56	0.04	7.84
1893	13.7	13.8	−0.6	−1.2	+0.72	0.36	1.44
1894	13.6	16.5	−0.7	+1.5	−1.05	0.49	2.25
1895	14.7	15.3	+0.4	+0.3	+0.12	0.16	0.09
1896	15.2	14.9	+0.9	−0.1	−0.09	0.81	0.01
1897	14.6	14.0	+0.3	−1.0	−0.30	0.09	1.00
1898	13.4	15.1	−0.9	+0.1	−0.09	0.81	0.01
1899	13.3	16.9	−1.0	+1.9	−1.90	1.00	3.61
1900	14.6	13.6	+0.3	−1.4	−0.42	0.09	1.96
1901	13.1	16.0	−1.2	+1.0	−1.20	1.44	1.00
1902	15.1	14.0	+0.8	−1.0	−0.80	0.64	1.00
1903	14.0	14.2	−0.3	−0.8	+0.24	0.09	0.64
1904	13.9	15.9	−0.4	+0.9	−0.36	0.16	0.81
1905	15.3	14.5	+1.0	−0.5	−0.50	1.00	0.25
1906	14.2	15.6	−0.1	+1.6	−0.16	0.01	2.56
1907	14.4	14.0	+0.1	−0.1	−0.10	0.01	1.00
1908	14.1	13.5	−0.2	−1.5	+0.30	0.04	2.25
1909	14.3	14.5	±0.0	−0.5	±0.00	0.00	0.25
1910	13.6	15.0	−0.7	±0.0	±0.00	0.49	0.00
1911	13.6	16.5	−0.7	+1.5	−1.05	0.49	2.25
1912	14.4	14.1	+0.1	−0.9	−0.09	0.01	0.81
1913	15.9	13.1	+1.6	−1.9	−3.04	2.56	3.61
1914	13.9	14.6	−0.4	−0.4	+0.16	0.16	0.16
Means	14.3	15.0					
Sums					−7.34	12.97	35.25

[1] The previous paper (first note) appeared in this REVIEW, January, 1916, 44: 17-21.—EDITOR.

The temperature data for Erimo have been taken from the Annual Reports of the Central Meteorological Observatory, Tokyo. The daily mean temperature has been calculated from the 6 daily observations, and approximates very closely the true mean temperature. The San Francisco data have been extracted from Prof. A. G. McAdie's "Climatology of California" and the Annual Reports of Chief of the Weather Bureau (4° edition). The mean temperatures at San Francisco given in Table 1 are the sum of the mean maximum and mean minimum temperatures divided by two, and are not reduced to the true mean temperatures as Hofrat Prof. J. von Hann [2] already remarked. Von Hann has given a small table of corrections to be applied to the many-years' means to reduce them to the true monthly means. But it must be remarked that generally the corrections are different from year to year. Hence the San Francisco temperatures given in the above table differ from the true monthly means, and the difference from the true mean temperature is different year for year. This is specially the case when a secular variation having an amplitude of the order of magnitude comparable to that of the variation under consideration, is superposed on the latter. In such a case the usual method for calculating the correlation coefficient gives an unduly small value.

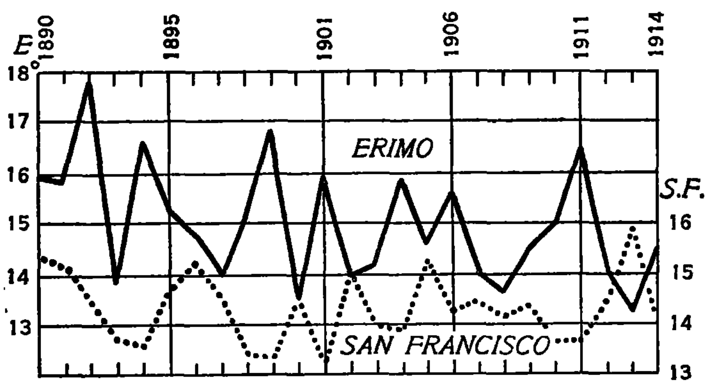

FIG. 1.—Graphic presentation of the fluctuations in the July temperatures at San Francisco, Cal., and Erimo, Hokaido, Japan, 1890–1914, inclusive.

From figure 1, which shows the above data in graphic form, we see that there is a well-established correlation between the July temperatures at San Francisco and Erimo; and the abnormally high temperature on the California coast is associated with abnormally low temperature of this [Japanese] shore of the Pacific.

But the correlation coefficient deduced from the data given in Table 1, is −0.34 and the probable error ±0.119. These values are simply suggestive of a connection between the July temperatures on both sides of the Pacific, but they are far from being conclusive of the connection. This apparent discrepancy between the conclusions arrived at by the graphic representation and the calculation, arises from the fact that the fundamental assumption for the calculation of a correlation coefficient is not fulfilled in the present case; that is to say, some unknown variations are superposed on the variation under consideration. Hence it will be rather advisable to compare the variation of temperatures year for year instead of the temperatures themselves. We give in Table 2 the variations of the July temperatures at San Francisco and Erimo. In this table δx means the varia-

[2] *J. von Hann.* Klimatologie von Kalifornien. Meteorol. Zeit., 1907, 455.
A. G. McAdie. Die wahre Mitteltemperatur von San Francisco, Kalifornien. Meteorol. Zeit., 1908, p. 330.